TECHNICAL MEMORANDUMS

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No. 709

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(Report of 1932 Rhön Soaring Contest)

By Walter Georgii

and

SYSTEMATIC OBSERVATIONS OF LOCAL CUMULI

By Roland Eisenlohr

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FUTURE PROBLEMS OF SOARING FLIGHT*

(Report of 1932 Rhön Soaring Contest)

By Walter Georgii

From 1926 to 1931 the performances at the Rhön Soaring Contests were continually improved. Without the slightest regress or temporary standstill, new soaring records have been made every August from the Wasserkuppe in the Rhön Mountains. The progress achieved during these years is best shown by a comparison of the successive records. The long distance flown at the first Rhön Soaring Contest, in 1926, was 21 kilometers (13 miles) and the highest altitude was 350 meters (1,150 feet) above the starting point. Now the corresponding records of the Rhön contests are 220 kilometers (137 miles) in 1931, and 2,500 meters (8,200 feet) in 1930. The number of gliders entered for the contests has increased in the same proportion. The success of the Rhön contests was undoubtedly the first step toward the present state of development and great popularity of soaring. This spirit is best promoted by good performances and successful flights. The rapid and uninterrupted improvement of the performances at the Rhön contests in 1926 to 1931 is not purely accidental. In 1926 and 1927 static soaring was methodically developed by successive flights from slope to slope and mountain to mountain, thus introducing the era of distance soaring. From 1928 to 1931 the most extensive soaring research was carried on, which put the theoretical possibilities of cloud, front and convection-current soaring at the service of practical flight and improved the performances to a hitherto unforeseen degree. As regards the future development of soaring flight and its prospects, it may be observed that all the sources of energy of static soaring are now practically known and that new revolutionizing discoveries must not be expected. This also applies to dynamic soaring which, on the basis of reports by Prandtl,

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Idrac and Sir Gilbert Walker, was again thoroughly discussed at the Second Scientific Soaring Session at Gersfeld in the Rhön. Dynamic soaring may still receive attention as an interesting experiment, but its practical importance for the improvement of soaring performances is negligible. Dynamic soaring may eventually become the highest form of unpowered stunt flying, but it will never amount to anything more.

Even when all new possibilities of soaring have been exhausted, the best should be made of given conditions, especially as regards cloud and storm-front soaring, by thoroughly training the pilots and improving the characteristics of the gliders. By thus developing the various methods of convection-current soaring, the performances will be improved in the same way as slope gliding was developed in past years by better methods. The era in which progress was achieved by the discovery of new flight possibilities has passed. Further progress may still be achieved by consistently pursuing the advantages afforded by good flight conditions, increased experience of the pilots, and better adaptation of the gliders to specific purposes. The progress of gliding activities is limited in Germany by climatic conditions. We must therefore moderate our ambitions and keep our plans within these limits. In the conclusion of his report on last year's contest, the most successful ever held on the Wasserkuppe, the author's statement that the success of gliding could not be made to depend on record-breaking performances alone, was based on these considerations.

The above introduction to our report on the Thirteenth (1932) Rhön Soaring Contest is justified by the fact that, for the first time in six years, the performances were not materially improved. This contest clearly outlines the possibilities of future gliding activities, showing that performances can be further improved only under particularly favorable and hence exceptional weather conditions. Such improvements are always dangerous and require better trained pilots and better gliders, especially as regards performances and equipment. The 1932 Rhön Soaring Contest must be considered as the beginning of a new era of natural progress in which the desultory advance of recent years will be replaced by systematic development. The main purpose of this development is an extension of the individual experience of a few outstanding pilots to the large number of soaring flyers.

The fact that gliding activities reach their climax in a period of great economic distress is very significant. The ranks of our soaring groups are full of flight enthusiasts eager for physical activity and fascinating occupation. They deserve great praise for having succeeded, in spite of the precarious economic conditions, in building costly high-class gliders and going to the expense of sending many men to take part in the soaring contests.

Before the closing of the list, 93 entries were received for the Rhön Soaring Contest. The Württembergischer Luftfahrt Verband held the first place with ten gliders of its subsidiary groups. The Schlesien group entered the contest with nine gliders. Sixty-six of the gliders entered, actually took part in the contest. It was unanimously recognized that this large number of gliders handicapped the contest. This was fully realized by the organizers from the beginning. They did not, however, want to check the enthusiasm and devotion of the many flyers to the Wasserkuppe and its contests by unmerited compulsory exclusion. The 1932 Rhön Soaring Contest has revealed the necessity of future restrictions through a more careful selection of the gliders and greater demands on the ability of the pilots. The Rhön contests are not intended to provide an opportunity for elementary training but for practice in performance soaring. In future each contestant will have to be familiar with the fundamental principles of piloting performance gliders and with the methods of static soaring. The contest is considered as training for cloud and storm-front soaring, to afford experience in altitude and distance performance flights. By increasing the demand on the ability of the contestants, the scope of the contest will be reduced in future but its aeronautic value will be increased.

The contest program was worked out along the same lines as previous programs which had proved satisfactory. The main purpose of all former Rhön contests was to improve the performances. This fundamental principle must necessarily be maintained in future, since it is decisive for the progress and permanence of gliding flight. The grading of the entries into "training" and performance groups corresponds to the classification of the pilots according to their skill. The experience of previous contests has led to a stricter grading into groups for juvenile inexperienced flyers and skilled pilots, in order to give the former the opportunity to win Rhön prizes. This policy was satisfactory and gained general approval. Suggestions were made to discard the classification according to the experience of the pilots in future and to adopt a grading based on the span of the gliders. The proposition involves the creation of three classes of gliders, the first not exceeding a span of 12 meters (39 feet), the second 16 meters (52 feet), and the third for any span above 16 meters, without other restriction. According to the regulations, the main prizes were offered for the best general performances, without distinction of classes, and special class prizes open only to gliders of the respective spans. No allowance was to be made for the different degrees of experience of the pilots. This proposition requires careful consideration. It cannot be allowed to affect the basic idea of the Rhön contests which is to contribute toward improving the performances. A division into classes according to the span gains full approval, inasmuch as it promotes the development of efficient gliders of fairly small span and prevents gliders of excessive fineness and large span from being built by groups lacking the necessary means and experience. Besides, such gliders may be used only for special purposes, which lie outside the sphere of activity of any one soaring group. One feels hardly justified in accepting the lowest class of gliders, with a span of less than 12 meters, for the forthcoming Rhön contest on account of the risk of encouraging soaring groups in general to build gliders with such a small span. The regulations for next year's Rhön Soaring Contest may be tentatively based on a division into two classes, for gliders with spans of more and of less than 16 meters. It seems desirable to make some allowance for the different degrees of experience of the contestants in order to prevent experienced pilots from competing on the same basis with inexperienced ones.

As usual, the main prizes in the training contest were awarded for endurance and altitude flights, on the basis of the maximum total time and altitude. The winner of the endurance flight of the training contest was Hakenjos of the Württembergischer Luftfahrtverband in the "Lore," with 31 hours. Dittmar in a "Kondor," with 25½ hours, and Schleicher of the Schwabach group, in "Ozite," with 20 hours, were second and third, respectively. A comparison of these times with the corresponding figures of last year's contest shows the unusual enthusiasm of the juvenile flyers of this year's contest. The best time of the Twelfth Rhön Soaring Contest was 18 hours, considerably less than this year's. Hakenjos, who had already competed for this prize in 1931, doubled his record of the previous year. The result of the second main prize, for the highest altitude, is slightly below the corresponding performance in 1931. The highest altitude of five flights was 2,082 meters (6,830 feet) in 1931 and 1,975 meters (6,480 feet) (Hakenjos) in 1932.

Only a few of the 334 flights of the training contest are given in Table I. The remarkable performances of our juvenile flyers are shown in this table. These performances are not always fully appreciated, owing to the demand for sensational records. This table is therefore particularly significant as a testimonial to the splendid performances of our juvenile flyers which alone establishes the success of the 1932 Rhön Soaring Contest. This list bears witness to the contribution of the contests toward making difficult flight performances more general. The list of endurance flights would be too long if all the one-hour flights were included. Hence only flights of at least 3 hours are included. Last year only one flight exceeded 3 hours, whereas this year several pilots attained this figure. Dittmar, Hakenjos, Peters, and Schleicher took the lead. With untiring perseverance they raised the maximum time from 8 to 12 hours. The Rhön endurance record of 9 hours 36 minutes, made by Lieutenant Hemmer in June, 1930, was broken three times this year. The victory in this hard contest for the Rhön endurance record was finally won by Schleicher in "Ozite" on the last day of the contest. He made a 12-hour flight in the restricted upwind region on the south slope of the Wasserkuppe under particularly difficult conditions due to very squally weather. Schleicher's performance is particularly remarkable, considering that he was participating for the first time in a Rhön contest. He won for his Schwabach group a Klemm-Argus airplane donated by the Transport Minister.

The altitude flights of the "training" pilots were as remarkable as the endurance flights. Owing to the large number of entries, however, only the performances which exceeded 300 meters (984 feet) are given in Table I. Dr. von Diringshofen led in the training contest with an altitude of 695 meters (2,280 feet). Ahrens, in the "Krefeld," was second with 635 meters (2,083 feet). The heights above 300 meters (984 feet) were reached in cloud upwind. The great number of these flights shows that the aim of teaching "training" pilots the principles of convection-current flight was accomplished in many cases during the contest. Hakenjos, whose unusual skill in convection-current flight was an excellent example to other contestants, contributed greatly toward the success of the altitude flights of the training contest.

July 28 was the great day for the juvenile flyers. On that day a large squadron of 17 gliders took off from the Wasserkuppe for a cross-country flight and covered a total distance of approximately 800 kilometers (500 miles). Seven of the 17 gliders were flown by pilots who were having their first experience in distance flying. The distances are extremely good for inexperienced pilots, being more than twice the distance required by the contest regulations. Three flights exceeded 40 kilometers (25 miles) and three others 30 kilometers (18.6 miles). (See Table I.) These performances can be fully appreciated only by making allowance for the reluctance of juvenile flyers to leave the familiar upwind zone and landing grounds near the starting point and to set out for new zones of upcurrents in unknown regions, often leading to forced landings under very difficult conditions. This year's contest frequently evidenced this natural reluctance of inexperienced and even of performance pilots.

All difficulties, however, were surmounted on July 28. The high altitudes reached in a propitious cloud upwind were very tempting and promised good distance performances. The success justified the stake. Most of the juvenile flyers, although taking part for the first time in a Rhön contest, were able, after only two weeks' experience, to accomplish the performances shown by the results of the contest. They flew to a fixed destination, the Milseburg, and returned to their starting point (Hakenjos), a performance which, only a few years ago, required the skill of the most experienced pilots. These results fully justify the designation of the Rhön contest as the high school for soaring. The question as to whether local contests can be substituted for the Rhön Training Contest is answered by these performance figures. Local contests are training contests. Their specific purpose is training in gliding and soaring. The Rhön Training Contest is not intended to train new pupils, but to introduce juvenile pilots with some soaring experience to the methods of performance soaring. This object was fully attained by the 1932 Rhön Soaring Contest.

The death of two contestants cast a shadow over the 1932 Rhön Soaring Contest. Flying at the cloud limit, Herbert Rüdiger, of the Schlesien group, went into a dive, probably in attempting to nose down from the cloud. He was unable to recover from the dive and crashed, the wings breaking off near the ground. In the performance contest, Günter Groenhoff was killed after a poor start on the west slope of the Wasserkuppe. The loss of two comrades, one of whom was the leader and master of German soaring flight, greatly affected and handicapped the 1932 Rhön Contest. For ten years no such accidents had happened. Nor are this year's accidents ascribable to the performance requirements. These tragic events must not give rise to conclusions affecting the future progress of gliding activities. This was clearly realized by all the participants who decided to honor the memory of their dead comrades by an increased flying activity. Nothing could be more impressive than the squadron flight of 17 pilots on the day of Günter Groenhoff's funeral, on which a total distance of 800 kilometers (497 miles) was covered. On the same day Lieutenant Hentschel flew 16 hours in his glider above the Dörnberg near Kassel, thus establishing a new German endurance record for unpowered flight.

It is impossible to prevent all losses in future, but nothing should be neglected to avoid accidents. The construction of gliders should be given the most careful attention. It is inadmissible for the strength of a glider to be sacrificed to the cost. The men who build gliders must be fully conscious of their responsibility for the lives of pilots who are to fly them. The building activity of our soaring groups derives its value from the care, strictness, discipline, and sense of responsibility of their members. In spite of the sympathy and comprehension for the difficulties and efforts of the soaring groups, acceptance tests must be very strict. The difficult task of the acceptance official must not be made intolerable by regarding him as an enemy to the progress of soaring. The groups should, on the contrary, accept this official as a conscientious friend and faithful adviser. As stated above, the Rhön contest is not for pupils but for full-fledged pilots, to whom it affords an opportunity to become familiar with the secrets of performance soaring. The frequent crashes, especially in outside landings, must not be charged against the Rhön contest, but must be ascribed to the lack of experience of a great number of pilots, especially in landing on territory with which they are not familiar. This difficulty must be obviated at the soaring schools by means of training courses for advanced pilots. The dislike of juvenile flyers for distance flights is thus gradually removed, an important step toward promoting unpowered flight and distance soaring, its greatest service.

As in previous years, the main purpose of the 1932 performance contest was to promote distance flight to a fixed destination. Full allowance was made for the difficulties encountered by juvenile flyers in distance flights. Two main prizes were awarded to the pilots in the performance contest who had had but little experience in distance flying. The encouragement prize in the distance contest for pilots who had never before made a flight of more than 30 kilometers (18.6 miles) was awarded to the gliders "Schlesien in Not," flown by Deutschmann, "Askania," flown by Pernthaler, and "Leba," flown by Wallischeck. It is to be regretted that the more important prize, for a distance of at least 50 kilometers (31 miles) and for pilots participating in the performance contest only since 1931, was not won. Riedel and Röhm, who were particularly eager to win this prize, did not quite cover the required distance. Riedel flew a maximum distance of 45 kilometers (28 miles) and Röhm covered 47 to 48 kilometers (29 to 30 miles), thus closely approaching the contest requirements. The performance contest is much more affected by weather conditions than the "training" contest, since long-distance flights require good thermal upwinds (convection currents) or marked storm fronts. The 1931 Rhön Contest was particularly favored in both respects, so that a large number of records were made. This year the weather conditions were entirely different. There was practically complete stagnation with no alternatives of summer heat with good thermal conditions and strongly marked storm fronts with subsequent weather in the rear of the depression producing cumuli suitable for cloud soaring. Such changes in the weather are an essential factor of success for performance flyers.

A thunderstorm was anxiously awaited from the beginning to the last minute of the contest. Such a storm front, which normally forms on the west slope of the Wasserkuppe, did not develop during the 1932 Rhön Contest. On July 23, the day of Günter Groenhoff's death, a start was made for a storm flight. On another occasion the gliders were ready to take off, but the storm dissipated late in the afternoon before reaching the Wasserkuppe. The thunderstorm of July 23 was a difficult problem for the entrants and organizers of the contest. According to the weather reports the storm was expected from the west. Late in the afternoon the dark cloud wall of the thunderstorm actually appeared in the western sky but before it reached the Wasserkuppe another thunderstorm most unexpectedly approached from the southeast, a very unusual direction. The Wasserkuppe was thus finally surrounded on three sides by thunderstorms. Under these conditions it was extremely difficult to determine the best starting point and to regroup systematically all the gliders ready to take off. Only a small number of pilots followed the advice to start for the storm front from the north slope. Most of them started for the thunder squall on the south slope, but could not connect with the front upwind owing to the small height of the slope. They all landed in the Gersfeld valley. Two gliders which started from the north slope connected with the storm upwind and started for a distance flight before the front at a good altitude. The two gliders were the "Askania," flown by von Pernthaler, and "Wolkenbummler," piloted by Captain Jans. The particular weather conditions on July 24 are shown by the chart of the track of the storm front plotted subsequently from numerous observations. This chart clearly shows that the thunderstorm expected from the west did not reach the Wasserkuppe but passed west of the Vogelsberg, whereas another storm, with its center in Franconia, approached the west storm from the southeast. These very peculiar weather conditions were impracticable for soaring purposes. Pernthaler, who was making his first storm flight, solved the problem with great skill. Carefully keeping a sufficient distance from the storm front, he made a smooth and absolutely safe cross-country flight with the storm, his first long-distance flight of 32 kilometers (20 miles).

The question has often been brought up as to whether storm flights should not be discontinued on account of the dangers involved. These flights are often extremely dangerous, owing to the great aerodynamic forces released by the storm, which are often too much even for the skill of experienced pilots and the strength of the most reliable gliders. It is therefore unnecessarily reckless and daring to fly into a storm. Pilots are expressly warned against starting on storm-front flights, unless they are thoroughly acquainted with the peculiarities of the storm front and have expert advice. Soaring groups and pilots without the necessary experience should on no account attempt unplanned storm flights. A storm-front flight is justified only when the pilots are thoroughly acquainted with its methods. They must start before the arrival of the actual squall front and keep several kilometers ahead of the following cloud "roller." When there is danger of their being drawn into the cloud and losing the outlook over the storm front, they should immediately fly to the undisturbed zone in advance of the storm front and take new bearings with respect to the front. Many starts have already been made from the Wasserkuppe for storm-front flights. No glider ever got into a critical situation, because expert advice is given to all pilots, who are strictly bound to conform to the instructions regarding storm-front soaring. Flight at a reasonable distance ahead of the storm front, in strict observance of the instructions, offers no excessive danger. On the contrary, barograms and pilots' reports show that, once the ceiling is reached, the storm-front flight is usually very smooth and causes the flyer less trouble and effort than a distance flight in a slope or cloud upwind. In this respect the experience of previous contests is fully confirmed by Pernthaler's storm flight.

A chart of the upwind zone ahead of the storm front, with the corresponding flight path of a glider, was plotted on the basis of recent investigations, which were not in the least influenced by previous storm-front flights. The new feature of the diagram is the assumption, confirmed by observation, that the actual storm front near the ground is preceded by an advance of cold air higher up. Heating near the ground and cooling off higher up result in a great instability of the intermediate air layers, which produces a strong, free upward motion. The region of marked convection currents lies between two and three kilometers (1.24 to 1.86 miles) ahead of the storm front. Front soaring flight must be made in this upwind zone and not in the forced up-current which develops forward of the cold-air wedge moving along the ground and closely ahead of the actual cloud "roller." The pilot should avoid the upwind zone of the cloud "roller" which involves the danger of a rapid dropping into the lower clouds and hence into the actual storm. According to the slope, the start for the storm is made in the brief period of calm which precedes the actual storm front, the large upwind zone of the storm cumulus being approached in a glide (fig. 2,1). Thus Pernthaler connected with the storm front in this year's contest. The start may also begin with a normal slope flight before the storm, the rising storm being approached from the altitude reached with the slope upwind. Inasmuch as the wind normally veers with the storm, the trajectory of the start is first inclined downward with respect to the approaching storm and the glider has to be flown from the windward to the leeward slope with approaching storm front (fig. 2,2). In the third way, the glider awaits the arrival of the storm front and starts toward it with the wind which sets in at the beginning of the squall. The storm "roller" being very closely approached in this case, the storm front must be left immediately after the start, thus bringing the glider out of the danger zone into the extensive region of up-currents, 1 to 3 kilometers ahead of the storm front (fig. 2,3). In slope starts toward a storm, a sufficient difference between the heights of the starting point and the outlying land is assumed in all three cases, so that the glider may have enough excess altitude to contact with the actual upwind zone ahead of the storm front. All three methods of starting were successfully employed on the Wasserkuppe last year (1931). In the Rhön Contest of this year (1932) most of the gliders started on July 23 from the south slope of the Wasserkuppe, immediately after the storm set in from the south and in accordance with the third of the above starting methods. Owing to the small elevation of the south slope of the Wasserkuppe above the outlying territory, the gliders could not connect with the upwind of the storm front and had to land in the Gersfeld valley. Well-planned storm flights do not involve excessive danger and afford excellent opportunities for improving the performances of distance flight.

After Groenhoff's death the only serious competitors in the 1932 Rhön Long-Distance Contest which, for seven years, has been the main event, were Kronfeld, Hirth, Mayer, and Riedel. In no case were record performances required by the regulations of the distance contest, since particularly favorable and seldom-occurring weather conditions are necessary for such performances. A distance of 100 kilometers (62 miles) was hitherto required for the distance soaring prize. In view of the greater experience of the pilots, the distance was increased this year to 120 kilometers (75 miles). The condition was fulfilled three times in the 1932 Rhön Contest, twice by Hirth in the "Musterle," with 144 kilometers (89 miles) and 160 kilometers (99 miles), and once by Mayer in the "Pommerland," with 125 kilometers (78 miles). Hirth and Mayer took the frequently flown route from the Wasserkuppe over the Werratal, along the Meiningen-Oberhof-Arnstadt line over the Thüringer Wald and from there northeast to Erfurt and Weimar. Wolf Hirth, often admired for his unusual skill in circling to great heights in very narrow local upwind zones on the west slope of the Wasserkuppe, won the contest again this year. The rating of the performances is unaffected by their falling 40 to 60 kilometers (25 to 37 miles) short of the 1931 distances. Much more important than the absolute number of kilometers flown, which depends on certain weather conditions, is the fact that present-day soaring methods and the skill and experience of the pilots enable distances of more than 100 kilometers (62 miles) not only to be flown occasionally but in regular scheduled flights which can be repeated at will under suitable weather conditions. The great progress lies in the methodical accomplishment of these flights and their frequent repetition even outside of the contests. When, instead of being exceptions, such flights can be made systematically under certain weather conditioms, they cease to be the special privilege of a small number of particularly skilled pilots and become accessible to a larger number of soaring flyers. Soaring instruction is now relied upon to familiarize all advanced glider pilots with the methods of long-distance flights. This result can be fully reached, as shown by some pilots of this year's contest who entered the ranks of the long-distance flyers for the first time.

The flights of H. Mayer, on July 27 and 28, are outstanding aeronautic achievements. The significance of these flights does not lie so much in the flown distances of 70 and 125 kilometers (43 and 78 miles), as in the altitudes reached in systematic, carefully planned blind flight in cumulus clouds. On July 27, Mayer flew toward a small approaching shower front. At the Hohe Rhön a strong upwind drew him into the cloud. In uninterrupted ascent, systematically controlled by the turn indicator, Mayer circled through and nearly to the top of the cumulus cloud. The barogram is remarkable and resembles certain altitude curves already plotted in similar flights by Kronfeld, Groenhoff and Bedau. The elevator-like ascent of the glider began suddenly at an altitude of 1,400 meters (4,590 feet) (fig. 3) and continued, with increasing velocity, up to 2,800 meters (9,180 feet). According to Mayer's account, the air in the cloud was very squally. It rained at some height and hailed above 2,000 meters (6,560 feet). The descent also took place in the cloud. The glider was kept constantly in a normal position by means of the turn indicator, the high speed of descent being ascribable to a strong downwind in the cumulus cloud. The vertical velocities of the air in the cumulus, which are deducible from the altitude-time curve and from the speed of vertical descent of the "Pommerland," are extremely interesting. In climb, the upwind velocity increases from 3 to 5 meters (9.8 to 16.4 feet) per second between 1,500 and 2,400 meters (7,874 feet), reaching 10 meters (32.8 feet) per second at 2,700 meters (8,860 feet). The downwind velocities in the cloud are smaller but still reach 3 to 4 meters per second between 2,000 and 2,700 meters. The possibility of theoretically checking these results and demonstrating the remarkably good agreement between the calculated and observed values was particularly helpful. This permits attributing a real practical significance to the vertical velocities of the air which can be easily found by aerological ascents.

The energy-mass diagram ("emagram") of the aerological flight at the Wasserkuppe on the afternoon of July 27, was derived by a formerly described method (reference 1). This diagram, which shows the temperature difference between the dry adiabatic and damp adiabatic and the actual temperature curve, is a criterion of the instability of the air, from which the vertical velocity of the air can be easily derived by a formula developed by P. Raethjen (reference 2). Figure 4 shows marked damp instability of the air on July 27. Theoretically, the velocity of the rising air in the cloud increases from 0 to 7 meters per second between 1,100 and 2,100 meters. Above 2,100 meters (6,890 feet) the vertical velocity settles about 7 to 8 meters per second. The values derived from the barogram of Mayer's flight are also plotted in figure 4. The theoretical curve of the vertical velocity agrees with the compensated curve of the observed values.

Mayer's flight on July 28, was as remarkable as his first flight and scientifically of equal value. After a short flight on the west slope of the Wasserkuppe, Mayer again made a blind flight in a cumulus cloud, reaching an altitude of 2,000 meters (6,560 feet). The vertical velocity of the air in this cloud was 2 meters per second. From this altitude Mayer started on a distance flight. Before reaching the Thüringer Wald he entered a large cumulus cloud which he traversed from the bottom to the top at 2,600 meters (8,530 feet). According to the explanations given by Mayer, the variations shown by the barogram at the top are due to the fact that, after leaving the cloud laterally, he repeatedly reentered it in order to reach the maximum possible height. The fearlessness with which Mayer systematically faced the unknown dangers of the cloud, such as squalls, hail and ice formation, and the great confidence with which he accomplished these cloud flights, using a turn indicator, compass and variometer, resulted in one of the most remarkable performances (fig. 5) in the history of soaring. Mayer's flight on July 28, in which he covered a distance of 125 kilometers (78 miles) and established his claim to the main prize for distance soaring. Far more important, however, than the distance is the altitude reached by Mayer. In general, a greater impression is produced by a 200-kilometer flight but, from the aeronautic standpoint, such a performance is outweighed by Mayer's two altitude flights in which, for the first time, cumulus clouds were traversed from bottom to top in systematic instrument flight of methodical accuracy and regularity. Mayer's two altitude flights gave value to the 1932 Rhön Contest and set goals for the future. Great heights are necessary for long distances. The altitude can be increased by systematic blind flight in cumulus clouds. This naturally enables an increase of the distance. The dangers of such flights, which are chiefly squalls, hail and ice formation, should not, however, be underestimated. Compared with such flights, storm-front soaring is only fair-weather flying. Such flights require strong and stable gliders with pilots trained in blind flying. We are glad to express our gratitude to the Deutsche Verkehrsfliegerschule (German School for Transport Pilots) for giving several pilots preliminary training in blind flying.

As mentioned at the beginning of this report, soaring has now reached a stage where the knowledge acquired from the experience of recent years, through a small number of bold pioneer flights, can be systematically developed. Systematic methods must replace daring experiments. Front soaring flights and Mayer's altitude flights are both systematic applications of the experience gained in the first pioneer flights of this kind by Kronfeld and Groenhoff in 1929. Instead of performances increasing by leaps and bounds, this stage of development is characterized by a progressive performance curve flattening out toward the maximum value. This performance curve is plotted in figure 6 for the three main cases of soaring. The possibilities of slope soaring seem to be fully exhausted. The curve for convection-current soaring, especially for flight without clouds or under clouds, is already quite flat, thus apparently approaching the maximum performance obtainable in Germany. The storm-front soaring curve alone has a steep gradient and permits the anticipation of further improvement in the performances.

Since the possibilities of gliding are limited in Germany by climatic conditions, we need to look elsewhere for opportunities to improve the performances further. Soaring flights in mountainous regions offer alluring prospects. Several test flights have already been made in the high Alpine territory of the Jungfrau and the Bavarian lower Alps in the vicinity of the Chiemsee. They have shown the importance of the problem, but also the difficulties and dangers involved in its solution. The crossing of the Alps in a glider, without being towed, may be successfully achieved in the present stage of soaring development. According to preliminary investigations, the best route is that leading from the extremity of the Inn Valley to the Brenner and from there over Bozen to the lowlands of northern Italy. A glider crossing the Brenner must fly at an altitude of at least 3,500 meters (11,480 feet) in order to reach fairly suitable landing ground near Bozen. Such a height can only be reached under unusually good weather conditions, inasmuch as observations show that the Alpine peaks are wrapped in clouds, making flight impossible, on 80 percent of the days with northwest winds. These winds are particularly favorable slope upwinds for the flight to the Brenner. Moderately windy weather with strong convection up-currents, such as occur in the center of high-pressure areas, seems to be required for the flight. Only on such moderately windy days are Alpine peaks cloudless in at least 50 percent of the cases. Another advantage of such days is the absence of foehn down-currents, very prejudicial to soaring, which are found on windy days on either the southern or northern slope of the Alps, according to the direction of the wind.

Apart from the crossing of the Alps, which is a tempting aeronautic and scientifically interesting problem, a flight along the Alps, from west to east or vice versa, according to the direction of the wind, offers the possibility of greater performances. A slope flight from the Inn Valley to Vienna, over a distance of 300 kilometers (186 miles), starting from the lower end of the valley, is neither particularly dangerous nor difficult with northwest winds. A moderate northeast wind with summer insolation offers still greater possibilities. In this case an unbroken mountain range forms a glider route to Lake Constance, from which Lake Geneva can easily be reached. The solution of these problems is not simple. The experience hitherto gained in Alpine soaring shows, on the contrary, that plans for the future should be made with great care, but the continuation of the test flights in the Alps is is one of the necessary present-day tasks of unpowered flight.

The possibilities of soaring flight in tropical countries have hitherto been completely unexplored. The progress of soaring in convection upwinds necessarily calls for a rational utilization of the possibilities afforded in the "home" of convection currents (the tropical regions), which are affected neither by seasons nor by changes in the weather. The regularity with which daily soaring flights can be made in tropical and subtropical regions permits the contemplation of the possibility of organizing unpowered flight on an economical basis in these regions. A long time ago the International Commission for the study of Unpowered Flight invited the attention of aeronautic circles to an investigation of the soaring possibilities in the tropics and last year (1931) emphasized the necessity and importance of test flights by the adoption of a resolution. The often-mentioned energy-mass diagram of the air gives, theoretically, an idea of the possibilities of convection-current flights in the tropics. Figure 7 shows an "emagram" on the afternoon of clear summer days over Lindenberg near Berlin. According to the relative position of the dry adiabatic to the temperature curve, the very dry atmosphere was unstable.* The convection upwind extended to an altitude of 2,000 meters (6,560 feet). Corresponding to the increasing instability of the air, the calculated vertical velocity rapidly reached 1.6 meters per second at 500 meters (1,640 feet) above the ground. Then followed a stratum of constant upwind velocities from 500 to 1,600 meters (5,250 feet). Above this altitude the vertical velocity fell off rapidly. These conditions are normal on cloudless days in our climate. It is therefore impossible to reach much greater absolute heights than 2,000 meters in convection upwinds only. The best upwind velocities are usually found between 500 and 1,500 meters. Similar conditions are encountered in the dry, hot climate of the subtropics. Figure 8 is an "emagram" plotted on the afternoon of a midummer day in Egypt.

In view of the great uniformity of the weather conditions in Mediterranean countries in summer, this curve is

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*The vertical velocities of the air were calculated by a formula proposed by F. Linke in Meteorologische Zeitschrift, 1928, p. 259.

typical of the summer period in those countries. The upwinds are very much like the convection upwinds on cloudless summer days in our climate. The maximum upwind velocity again lies at an altitude between 500 and 1,600 meters and is practically constant within this stratum. Owing to the slightly greater instability of the atmosphere in subtropical regions, the upward velocity increases to 2 meters per second. Unlike weather conditions in our country, with only occasional cloudless days, fair weather prevails in the subtropics for six months without interruption, thus permitting convection flights to be made with great regularity, daily from 9 a.m. to 5 p.m. These conditions are still more interesting in the tropics. The "emagram" in figure 9 gives an idea of the instability of the tropical atmosphere and of the resulting vertical velocities of the air. While the preceding examples apply only to practically cloudless weather, the "emagram" of the equatorial region shows the upwind conditions of tropical cumuli. The outline of the damp adiabatic, as compared with the temperature curve, shows a material increase in the instability of the atmosphere with altitude, so that the calculated vertical velocities of the air reach improbably high values.

Without attributing any particular importance to the calculated velocities, the upwinds in tropical cumuli are undoubtedly considerable and the altitudes attainable in soaring flight greatly exceed the maximum values in our climate. No effort should be spared to obtain German participation in the investigation of the possibilities for soaring flight in the tropics. The scientific importance of the question alone would fully justify such an expedition. On the other hand, sporting considerations should cause Germany to attach greater importance to the unusually favorable soaring possibilities outside its borders.

Great efforts were made to surpass the German soaring performances. The endurance record established by an American in a tropical region can hardly be surpassed in Germany. The American records already exceed a distance of 100 kilometers (62 miles) and an altitude of 2,000 meters (6,562 feet). We cannot overlook the fact that the summer season in North America affords much better opportunities for soaring flight than in Germany. The storm fronts in the United States are more pronounced, stronger and faster. In winter, the tropics can easily be reached from North America and the soaring flights continued there.

The time may be near, when, under the climatic conditions prevailing in Germany, we shall be unable to compete with the much better soaring conditions in other countries. Yet Germany, the birthplace of soaring flight, should strive to maintain its leading position. If the records cannot be further improved under the climatic conditions of our country, we should not hesitate to take advantage of the better conditions in other countries, to keep Germany in the lead, both as regards soaring records and scientific progress.

REMARKS BY MARTIN SCHRENK

Professor Georgii has shown us that the 1932 Rhön Soaring Contest embraced a large number of very excellent performances which would have been considered hardly possible a few years ago, even though no new records were made.

As a former glider pilot who participated in the first contests, I see no ground for pessimism. On the contrary the fact that there are now so many excellent pilots shows that the movement is developing normally on a sound basis. Peak performances do not constitute an end in themselves, but serve to mark progress on a broader base. These peak performances are of value only when it is shown that the best performances of the masters of yesterday are the ordinary performances of the pupils of to-day; that they are not simply isolated feats, but can be learned and duplicated.

The reverse of this gratifying development, as the lecturer has shown, is an increasing congestion in the Rhön contests. With many others, I am of the opinion that the number of participants in future Rhön contests must be limited. This will necessitate the strict selection of pilots and gliders. The selection of the gliders is relatively simple. The selection of the pilots would have been an insolvable problem a few years ago. Such is not now the case, however, because there are many fine training fields scattered throughout the country. I will mention only the Hornberg in Schwaben, the Dörnberg near Kassel, the Borken Mountains in the Ruhr region, Grunau in Schlesien, Leba in Pommerania, and the well-known Rossitten in East Prussia. All these fields are suitable and are provided with the necessary conveniences for holding regional contests which may serve as preliminary or elimination contests for the Rhön.

Behind this problem there is a great educational problem, the solution of which will here and there meet with considerable difficulty. So far as I can see, however, it is the only way to develop our soaring contests systematically, and especially the Rhön Contest in its original location. May the Wasserkuppe remain the Olympia of German soaring flight!

I hope you will pardon me if I lead out my old hobby-horse, namely, classification according to the span. I am much pleased that this plan which I have favored for ten years* is to be tried in the next contest. I am somewhat concerned, however, as to whether it will fulfill its real purpose in the proposed manner, namely, by restriction to a 16-meter (52.5-foot) class and an open class.

Professor Georgii fears that the introduction of a 12-meter (40-foot) class may lead many groups to build extremely light gliders, which will not have the requisite strength and durability and which will therefore introduce a new source of danger into the contests. It must not be forgotten, however, that all such fears can be eliminated by the addition of only 5 kg (11 lb.) of weight at the right place and that, moreover, a wing of great span is much more sensitive to wing vibrations than a wing of shorter span and therefore inherently more rigid. I believe that clubs which have built a sufficiently vibration-proof and durable 20-meter (66-foot) wing, can also build a 12-meter (40-foot) wing of equal reliability, especially if they bear in mind that greater improvement can be effected in the head resistance (profile and fuselage drag, correct joining of wing and fuselage, etc.) than in the weight. Moreover, it is possible to assist the clubs which have had too little experience in construction and, lastly, to eliminate unsuitable gliders by thorough inspection and testing.

I believe therefore that the 12-meter class should not be barred from the contests by reason of danger. Perhaps there is also fear of an excessive division of the very inadequate prize money. In this connection it may be

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*Presented for the first time before the first International Soaring Flight Session at Darmstadt in March, 1930, and published in the 1929 Yearbook of the Rhön-Rossitten Gesellschaft, pp. 88-91. See also Flugsport, 1932, No. 12, pp. 224-228.

mentioned that in the next contest only a few small gliders will probably appear, so that only a relatively small portion of the prize money (say 20 per cent) will be required for them.

As regards the purpose and tasks of the small class, in view of my previous utterances, I would here call attention only to the fact that the 12-meter class in its flight characteristics differs so much from the conventional design, that new tasks, suitable for especially maneuverable and swift gliders, can be evolved with good prospects of success. I am thinking, for example, of the utilization of very narrow upwind currents and the investigation of various dynamic effects recently observed in Gersfeld. Of course it is not easy to formulate such tasks for the next contest, but this will not be necessary, as our glider pilots have always shown that they can set their own tasks, if they are only provided with the proper implements.

In the 1932 contest, excellent cloud flights were made, especially by Mayer, who demonstrated the great advantage of a statically stable glider for such purposes. While Hirth with his "Musterle" reluctantly entered clouds, Mayer was little concerned, since all he had to do when his glider became unsteady, was to leave it to itself to resume a normal attitude. Unfortunately, statically stable performance gliders are still exceptional. It seems to me, however, that the time has arrived for this requirement, which for years has been accepted as a matter of course in the designing of powered airplanes, to be adopted also by glider designers, all the more since, according to the latest views, static stability requires no sacrifice in maneuverability.

In my opinion, there is still much to be improved in the flight characteristics of gliders. With the further expansion of soaring flight, it will be necessary to investigate the matter more thoroughly and to establish certain minimum requirements, which seem indispensable for safeguarding the rising generation of flyers. This also holds good for the strength requirements of gliders. Here also an increase in number brings about a corresponding increase in the possibilities of accident. The official specifications and tests should be severer than heretofore.

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1. Georgii, Walter: Twelfth Rhön soaring Contest, 1931. T.M. No. 671, N.A.C.A., 1932.

2. Raethjen, P.: Zur Thermo-Hydrodynamik der Böen. Meteorologische Zeitschrift, 1931, p. 11.

TABLE I. ENDURANCE, ALTITUDE AND DISTANCE FLIGHTS IN 1932 RHÖN TRAINING CONTESTS

Entry	Glider	Pilot	Total time	Total altitude five flights	Maximum duration	Maximum altitude	Distance
Flg. Vgg. Schwabach	Ozite	Schleicher	20 hr. 4 min.		12 hr.		
L. F. V. Aachen	Aachen	Peters	16 hr. 2 min.		10 hr. 50 min.	548 m	45.9 km
W. L. V.	Lore	Hakenjos	31 hr. 13 min.	1,935 m	9 hr. 44 min.	500 m	42.4 km
Dittmar	Kondor	Dittmar	25 hr. 32 min.	1,385 m	8 hr. 13 min.	390 m	43.5 km
W. L. V.	Stuttgart	Künzer			6 hr. 5 min.		30.4 km
Flgsp. Vgg. Offenbach	Wolkenbummler	Jans			4 hr. 44 min.	345 m	12.0 km
Anders	Rhönadler	Ponti			4 hr. 16 min.		
L. F. V. Krefeld	Krefeld	Ahlers(?)				635 m	
Sewering	Junkers	Renner	12 hr. 27 min.	1,470 m	3 hr. 56 min.	580 m	35.4 km
Aeroclub Warschau	Lwow	Lopatniuk	9 hr. 1 min.		3 hr. 5 min.	355 m	17.0 km
Fränk. V.f.L. Würzburg	Professor	Diringshofen				695 m	30.6 km

TABLE II. DISTANCE AND ALTITUDE FLIGHTS
IN 1932 RHON PERFORMANCE CONTEST

Entry	Glider	Pilot	Distance over 30 km (18.6 mi.) course	Altitude	Maximum altitude	Landed at
Schlesiergruppe DLV	Musterle	Hirth	160 km	920 m	920 m	Silbitz
"	"	"	143.5 km	645 m		Camburg S.
Testaflieg	Pommernland	Mayer	124.8 km	2,185 m	2,185 m	Apolda
"	"	"	70.1 km	1,840 m		Gotha
Kronfeld	Wien	Kronfeld	62.5 km	530 m	530 m	Neundorf Th.
"	"	"	54.2 km	490 m		Oberschönau
W. L. V.	Württemberg	Röhm	47.7 km	685 m	685 m	Schmalkalden
"	"	"	47.3 km	85 m		Waldfisch
Riedel	Rhönadler	Riedel	45.2 km	330 m	330 m	Liebenstein
Kronfeld	Austria	Kronfeld	41.1 km	180 m	530 m	Rohr i. Th.
Marcho-Sil.	Schlesien	Deutschmann	37.2 km	390 km	425 m	Vacha
Anhalter V.f.S.	Askania	Pernthaler	32.2 km	-	305 m	Eiterfeld

SYSTEMATIC OBSERVATION OF LOCAL CUMULI*

By Roland Eisenlohr

At the scientific session for soaring flight at Gersfeld in the Rhön, Mr. Blech showed several motion-picture films of cumulus formations which aroused general interest. The cloud pictures (with exposures at five-second intervals) showed, through their great concentration, a really dramatic evolution in the turbulence, disruption and piling up of the cloud portions. It is perhaps a defect of this method that it condenses an hour's development into the space of about a minute. Not every aviation club can bear the considerable expense involved. A thorough study of local cloud formations is recommended, however, to all clubs, in order to promote the spread of distance and cloud flying. The formation of cumulus clouds is everywhere more or less influenced by local conditions, e.g.:

1. By broad mountain valleys with considerable bodies of water;
2. By mountain slopes which at certain times are strongly heated by the sun;
3. By other local conditions, even in a level region, such as swamps, etc., where a sufficient formation of water vapor is possible.

Over grainfields, for example, less cumuli are formed than simple strong convection currents which are not susceptible of direct optical observation. We should, however, seek to utilize the valuable methods suggested by Blech and possibly to extend them in some other cheaper way by conducting everywhere systematic observations of cloud formation. If we here propose a graphic representation, it is possible only on the assumption that the individual observers are instructed in the principles of the formation of cumuli and their constant growth from below and disintegration at the top. The upward flow of warm air does not cease at the top of the cloud, but extends considerably above it. Even above a closed ceiling of clouds, one may observe, in a free balloon, strong vertical currents to a height of 1,600 to 2,000 feet above the clouds, which form cumuli on their upper side. The motions of the balloon are far too violent to proceed simply from heat radiation. Moreover, I was able to verify it

*"Systematische Beobachtung lokaler Cumulusbildungen." Z.F.M., March 14, 1933, pp. 136-137.

satisfactorily by attaching strips of crepe paper, ten to twelve feet long, to each corner of the basket, which indicated the direction and strength of the gusts. Such tests during free-balloon trips are very instructive and partially replace the statoscope.

Naturally a mountainous terrain is better suited for systematic observation of clouds, because here the region of cloud formation is more restricted than in a level country. For example, at my summer residence in the Black Forest, I was able, on hot days, to observe, over the south slope of the Kandel, 1,350 m (4,429 ft.) high, at a distance of about 7 km (4.35 miles) south from my place, and likewise toward the north over the broad Kinzig Valley near Hausach-Haslach, 14 km (8.7 miles) distant, magnificent cumulus formations of almost exactly the same shape from day to day. The accompanying sketches show the formation and periodic development of cumuli on the south slope of the Kandel in the summer of 1932. (The ground temperature was about 90° F. Arrows show direction of development.) The contour of the mountain affords a scale for determining the height of the clouds, if one is skilled in drawing. Otherwise the observer may hang a simple net in front of himself.

In the accompanying sketches (fig. 10) each mesh covers a field about 500 by 500 m (1,640 ft.), so that the whole net covers a maximum cloud height of about 2,000 m (6,560 ft.) above the Kandel. Of course the observer himself must be at a certain altitude. The sketches show the disruption of the upper clouds and their rapid dissolution, as also the effect of a gentle east wind.

It would, of course, be interesting to continue these observations throughout the year under other weather conditions and with other directions of the wind. The whole series of observations would then serve as a basis for determining a certain regularity of cloud formation, intensity of upwinds, etc. It would also be helpful to make simultaneous observations from two points, so as to obtain front and side views of the clouds.

These observations could occupy the nonflyers of a club in a manner which would be of interest to all. Such systematic observations, which would doubtless be encouraged by the weather bureau, would be beneficial for the development of soaring flight as well as for meteorology. Of course no more could be required of them than such sketches, which must be fairly accurate in scale, but systematic practice could with time yield useful results, especially for discovering new stretches and places for distance and high-performance cloud soaring flights. When, on the basis of these observations, we have more or less advance knowledge of the location of strong convection currents in certain kinds of weather, it will always be possible to find intermediate points with thermal upwinds which will aid in distance soaring flights. Auxiliary observations are also important. For example, while I was making the cloud sketches, a hen hawk (falco milvus) was soaring at a height of about 2,000 feet. This was quite unusual, as they generally circle at heights of 300 to 500 feet. Of course it was soaring in an upward warm-air current, which is doubtless common at this point and a knowledge of which would be important for a distance soarer.

Translation by
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for Aeronautics.

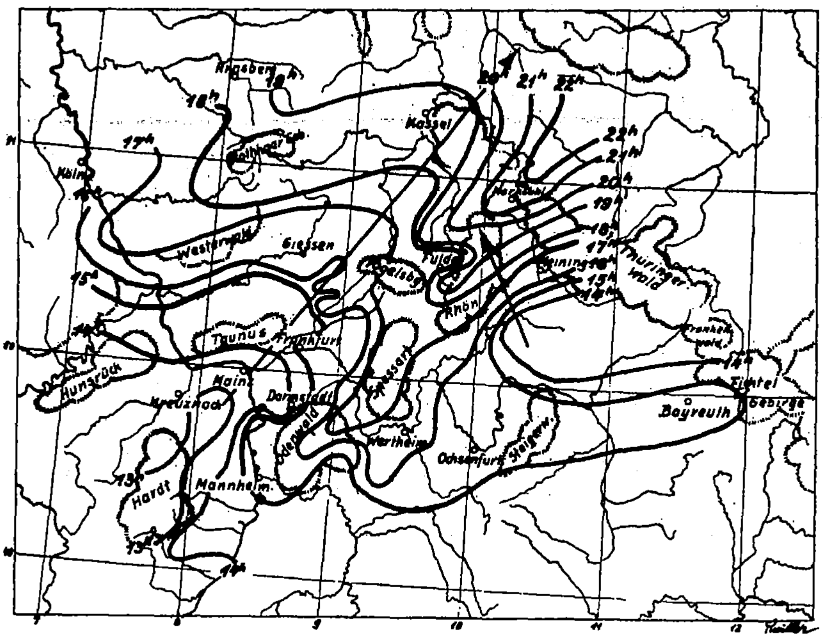


Figure 1.- Course of storm fronts on July 23 1932.

a. West slope of Wasserkuppe
b. Blind flight in clouds
c. West side of Thüringer Wald
d. Slope-wind gliding
e. Gliding (Fig.3)

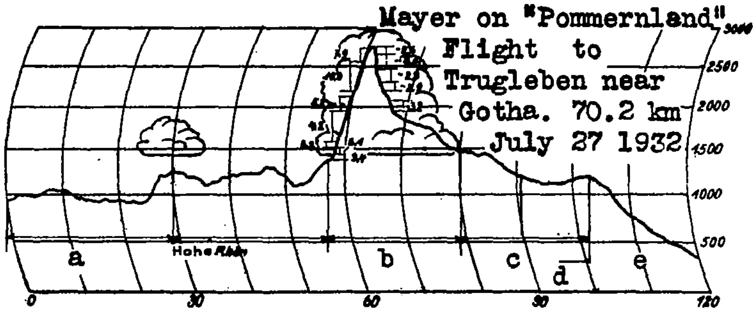


Figure 3.- Barogram of Mayer's cloud flight on July 27 1932.

a. West slope of Wasserkuppe
b. Blind flight in clouds
c. Blind flight in clouds
d. Rear side of Thüringer Wald
e. From Arnstadt to Weimar (Fig.5)

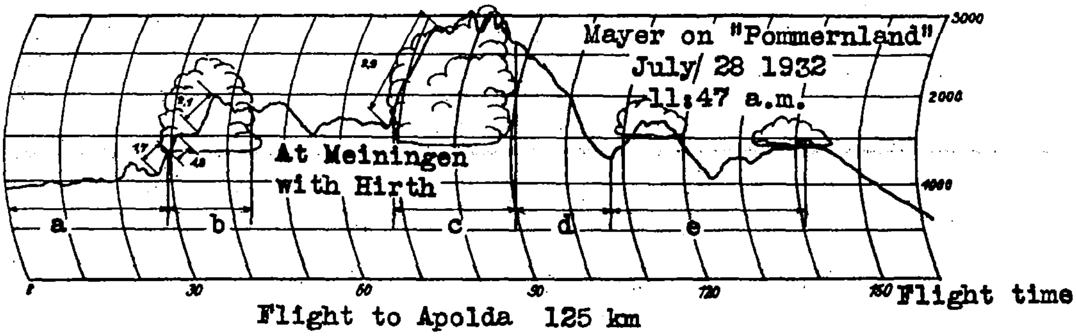


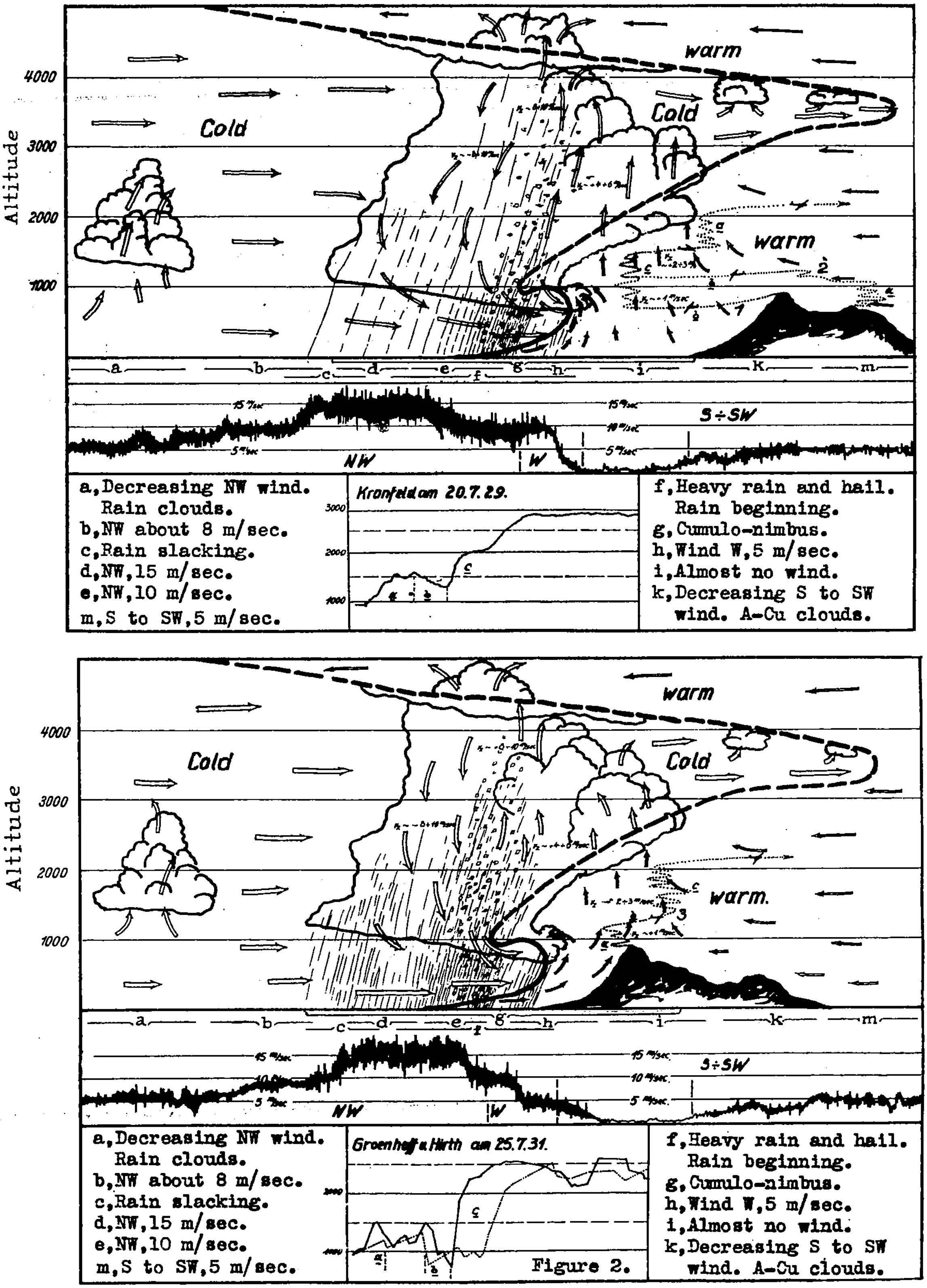
Figure 5.- Barogram of Mayer's cloud flight on July 28 1932.

FIGURE 2.-Diagram of storm front with cold air advance in upper strata.

Flight 1) The glider starts with the smallest wind velocity, shortly before the beginning of the squall and glides into the upwind zone of the storm cloud, 1 to 2 kilometers ahead of the "roller," from which point the ascent is smooth and regular. The upwind in this region is due to the marked damp instability of the air produced by cooling at the top and simultaneous heating of the air near the ground. The glider should not be allowed to approach the "roller" too closely.

Flight 2) The glider flies in the upwind of the windward slope. It leaves the slope with approaching storm and flies toward the storm front until the cloud upwind zone of the cumulo-nimbus is reached. From there on as in flight 1).

Flight 3) The glider starts shortly after the beginning of the storm squall which closely precedes the "roller." It gains some height in the slope upwind and partly in the up-current of the storm "roller." It is then necessary for the glider to fly farther ahead of the storm front and to enter the smooth and regular cloud upwind of the cumulo-nimbus 1 to 2 kilometers ahead of the "roller." From there on as in flights 1) and 2).


4000
3000
2000
1000
Altitude
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warm
Cold
warm
a b c d e f g h i k m
15 m/sec
10 m/sec
5 m/sec
NW
W
S÷SW
a, Decreasing NW wind. Rain clouds.
b, NW about 8 m/sec.
c, Rain slacking.
d, NW, 15 m/sec.
e, NW, 10 m/sec.
m, S to SW, 5 m/sec.
Kronfeld am 20.7.29.
f, Heavy rain and hail. Rain beginning.
g, Cumulo-nimbus.
h, Wind W, 5 m/sec.
i, Almost no wind.
k, Decreasing S to SW wind. A-Cu clouds.
4000
3000
2000
1000
Altitude
Cold
warm
Cold
warm.
a b c d e f g h i k m
15 m/sec.
10 m/sec.
5 m/sec.
NW
W
S÷SW
a, Decreasing NW wind. Rain clouds.
b, NW about 8 m/sec.
c, Rain slacking.
d, NW, 15 m/sec.
e, NW, 10 m/sec.
m, S to SW, 5 m/sec.
Groenhoff u. Hirth am 25.7.31.
f, Heavy rain and hail. Rain beginning.
g, Cumulo-nimbus.
h, Wind W, 5 m/sec.
i, Almost no wind.
k, Decreasing S to SW wind. A-Cu clouds.

Figure 2.

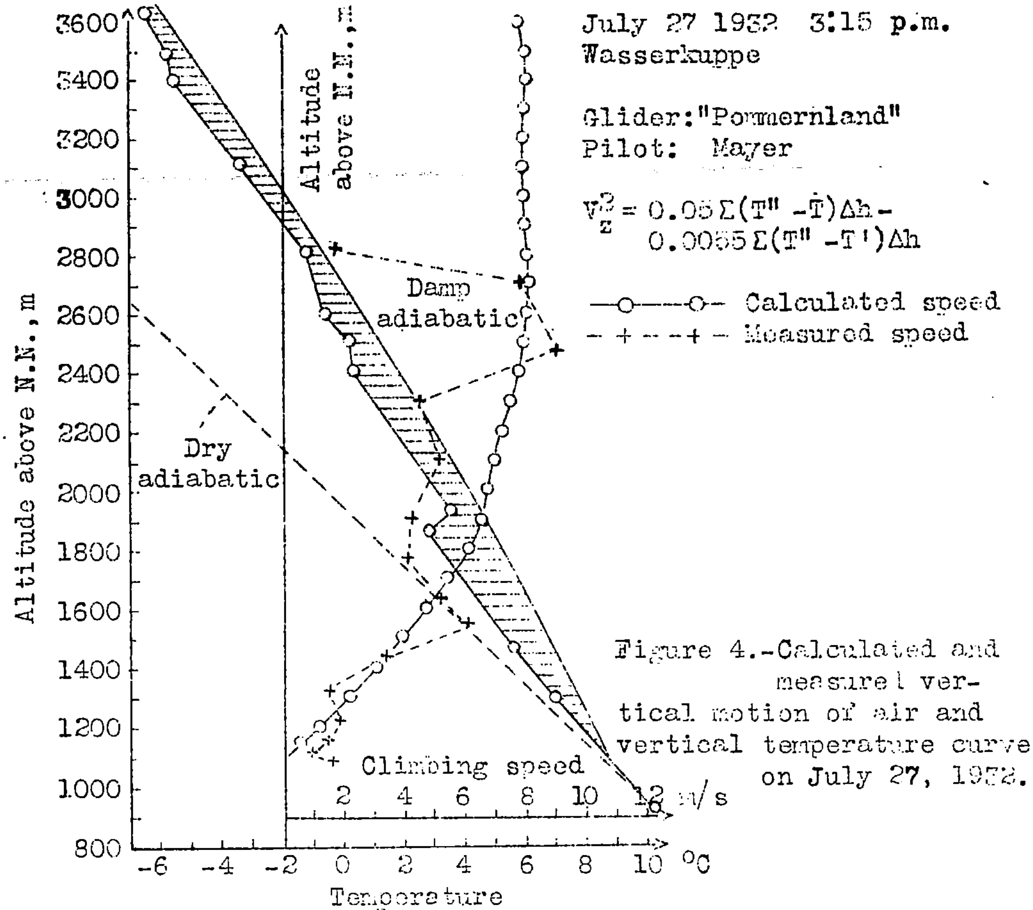


Figure 4.-Calculated and measured vertical motion of air and vertical temperature curve on July 27, 1932.

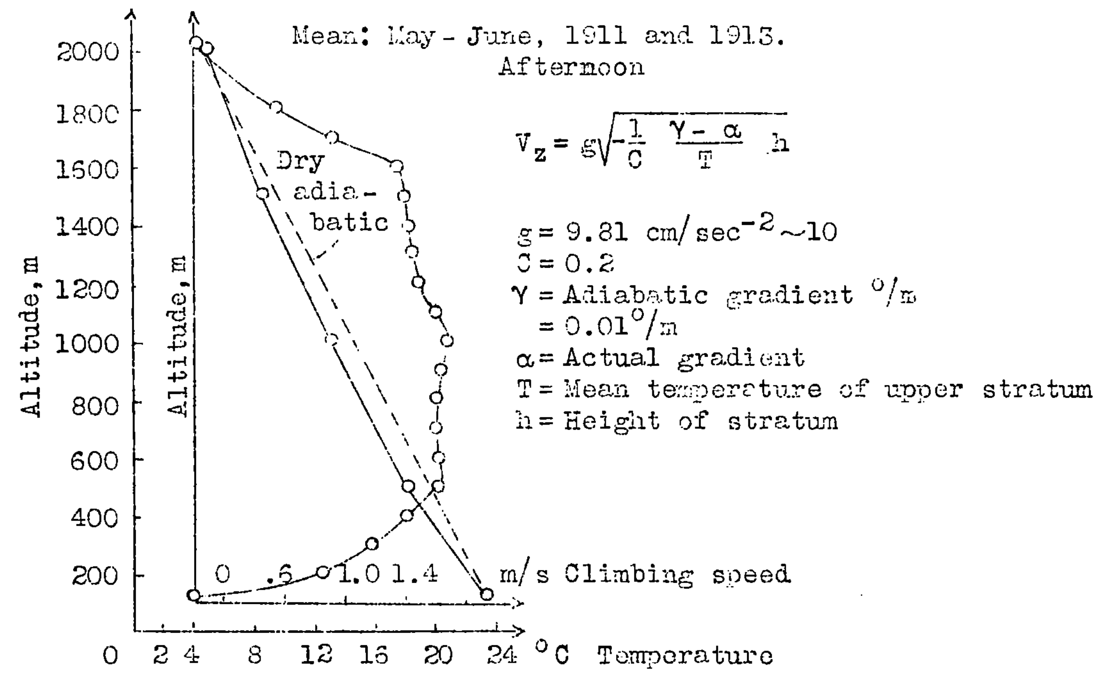
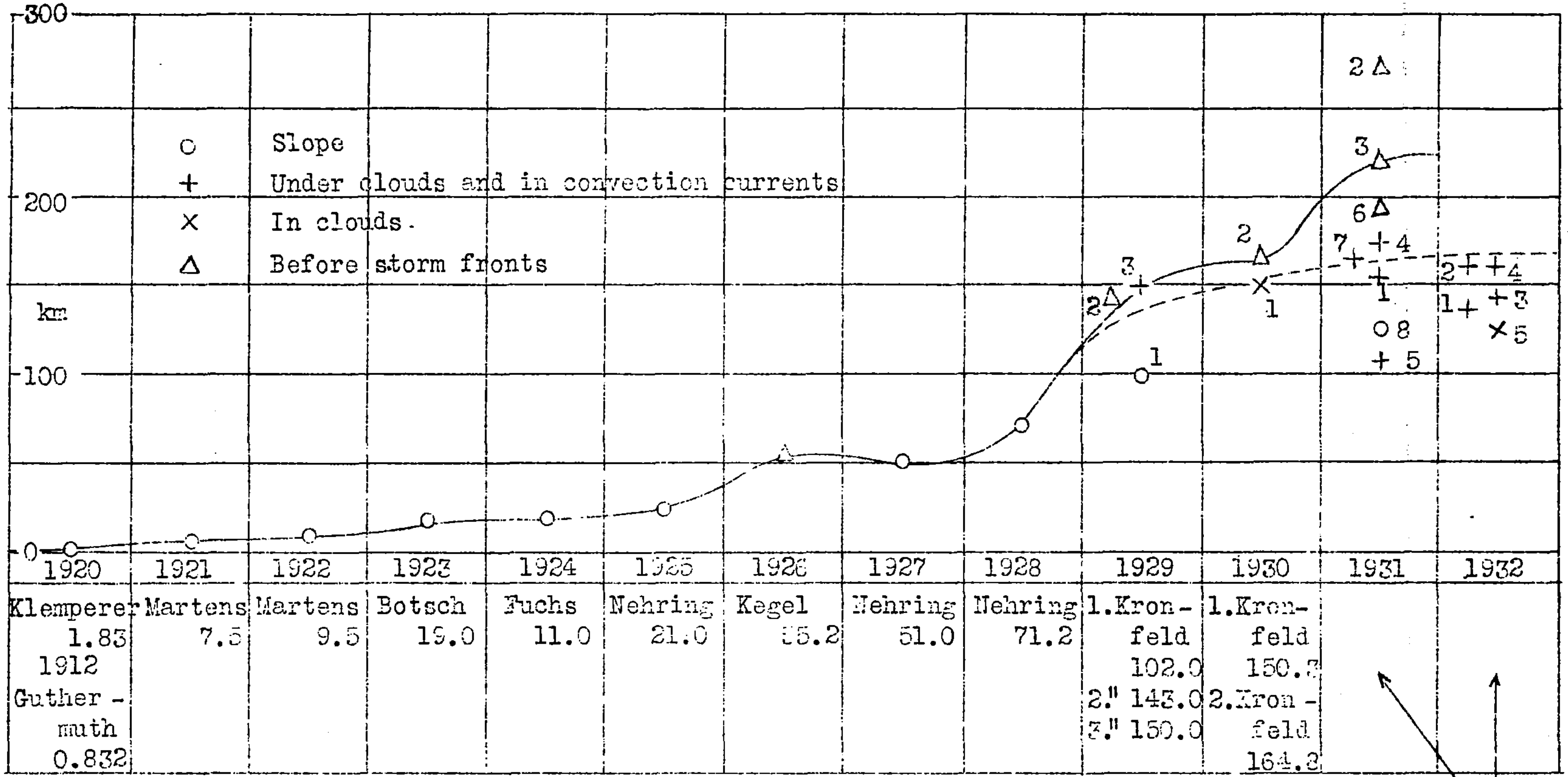


Figure 7.- Calculated vertical motion of air and vertical temperature curve on clear summer days over Lindenberg



1931, 1 Groenhoff 155.0, 2 Groenhoff 272.0, 3. Groenhoff 220.0, 4 Hirth 175.0, 5 Groenhoff 107.4
6 Hirth 192.5, 7 Kronfeld 160.0, 8 Groenhoff 125.0
1932, 1 Reidel 145.0, 2 Reidel 160.0, 3 Hirth 143.5, 4 Hirth 160.0, 5 Mayer 125.0

Figure 6.- Improvement of soaring- flight performances: Distance flight

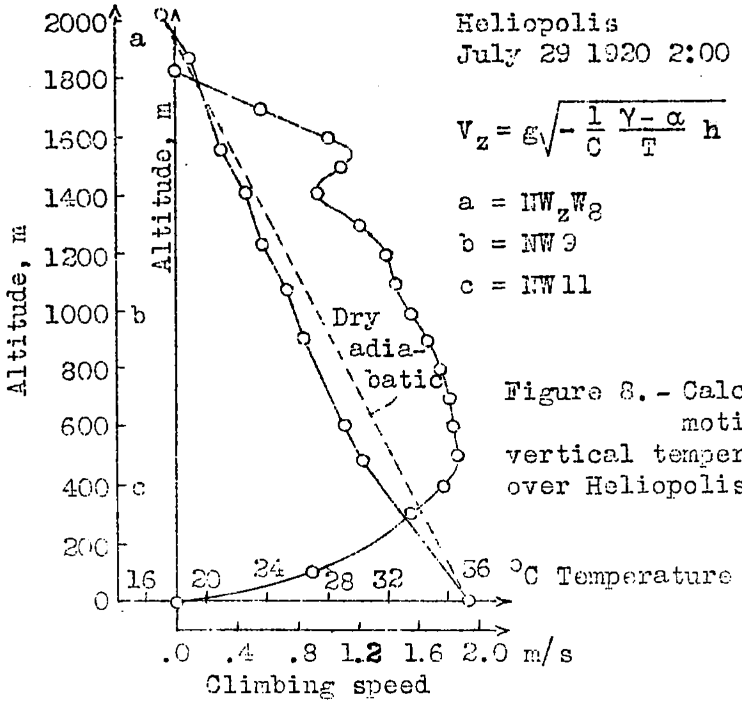


Figure 8.- Calculated vertical motion of air and vertical temperature curve over Heliopolis

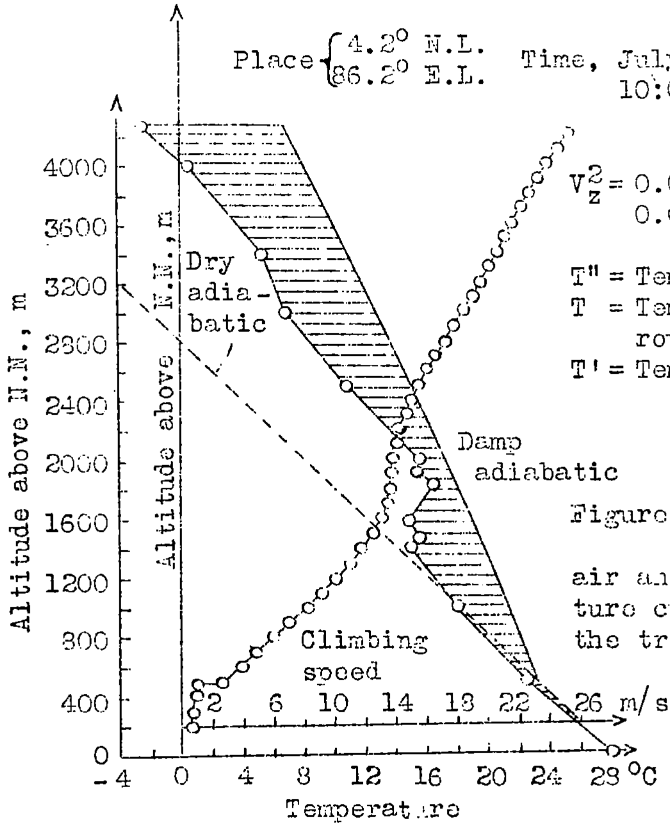


Figure 9.- Calculated vertical motion of air and vertical temperature curve. Example from the tropics

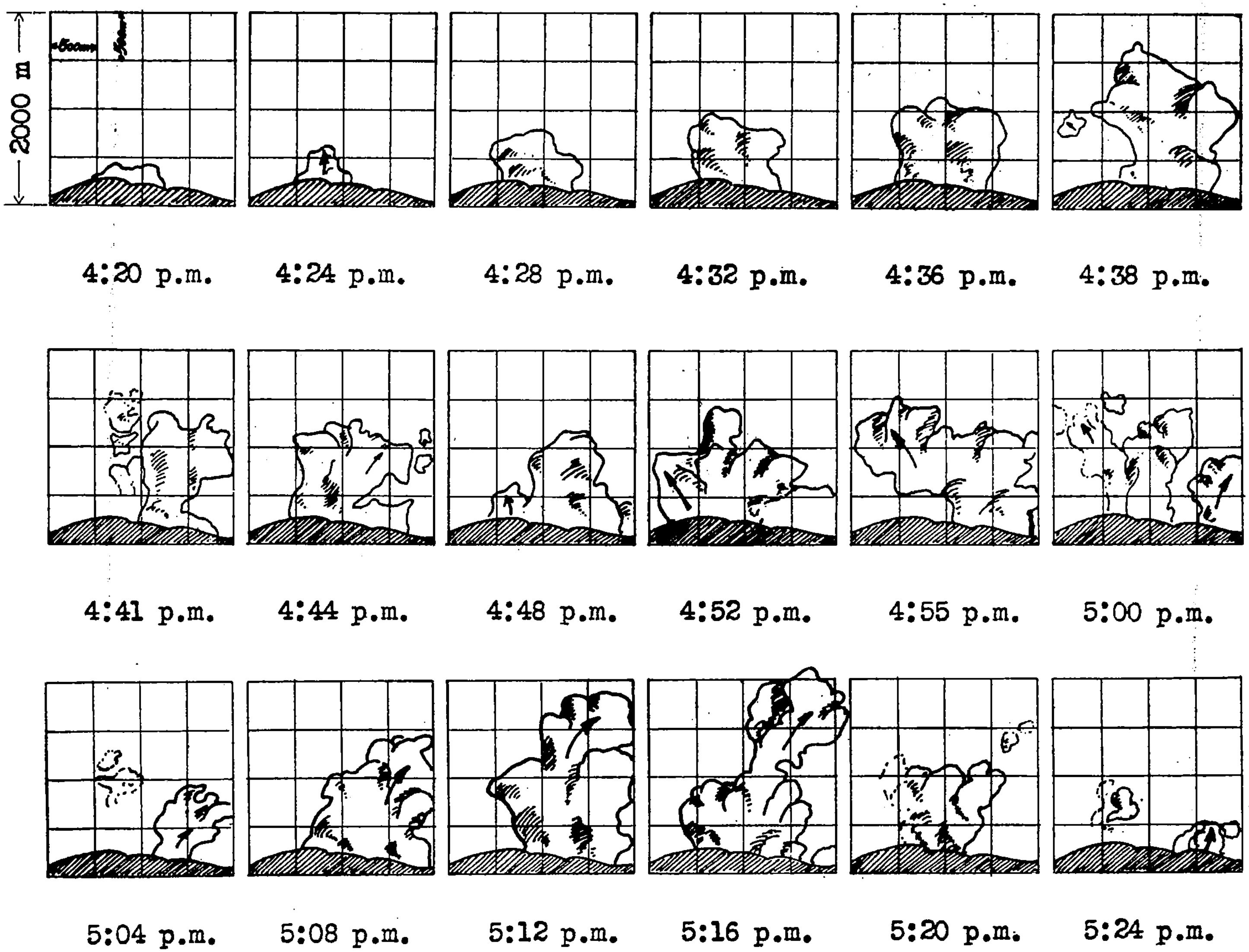

2000 m
4:20 p.m.
4:24 p.m.
4:28 p.m.
4:32 p.m.
4:36 p.m.
4:38 p.m.
4:41 p.m.
4:44 p.m.
4:48 p.m.
4:52 p.m.
4:55 p.m.
5:00 p.m.
5:04 p.m.
5:08 p.m.
5:12 p.m.
5:16 p.m.
5:20 p.m.
5:24 p.m.

Figure 10.